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ABSTRACT

This document is designed to help administrators and teachers plan, develop, and implement technology education (TE) programs. It provides a philosophical foundation and broad outline for constructing comprehensive TE programs that develop middle school and high school students' technological literacy by focusing on the ways in which ingenuity, processes, materials, devices, science, and mathematics may be applied to solve problems and thereby meet society's needs and desires. The materials presented focus on developing and evaluating curricula focusing on the following: applying technology systems; understanding technology's nature, impacts, and evolution; using technology to solve problems; making informed decisions about technological issues; using technology resources; applying science, mathematics, and other areas of study; becoming aware of/exploring careers; and achieving multicultural and gender diversity. The following topics are examined in the document's 10 sections: philosophy of TE and its relationship to society, learners, and school curricula; nature/scope of technology, technological literacy, and TE; vision for TE; TE learner outcomes; TE goals/subgoals; expected behavioral outcomes of TE; illustrative objectives; and curriculum development and assessment (development and evaluation of a TE program's philosophy, goals, scope/sequence, and instructional units). Appended are the following: glossary; discussion of the derivation and application of technology systems; and sample course descriptions. (MN)

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ED 399 464

TECHNOLOGY EDUCATION

A MARYLAND CURRICULAR FRAMEWORK

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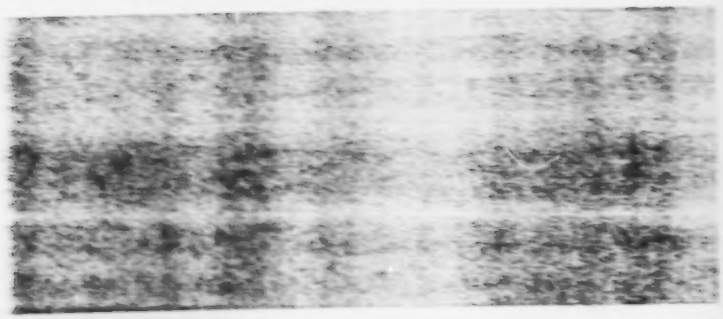

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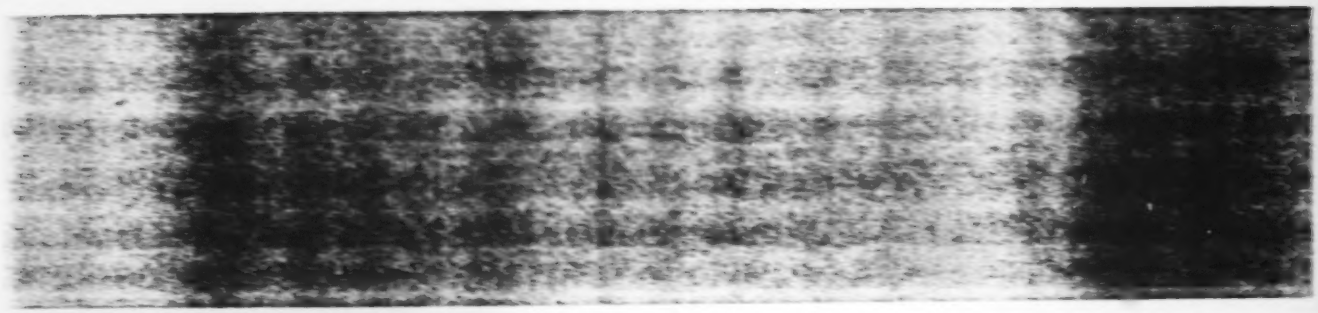
The real challenge before Technology Education is to achieve the promise that lies within it as a vital component in the education of all citizens. This can be done by taking advantage of the principles and understandings related to learning and behavior, and capitalizing on its rich and relevant content as well as its processes.

Donald Maley, Professor Emeritus
The University of Maryland



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The members of the Technology Education Curricular Framework Taskforce.

Barry Burke, Coordinator
Industrial & Technology Education
Montgomery County Public Schools

W. Harley Smith, Supervisor
Technology Education
Prince George's County Public Schools

Ken Smith, Resource Teacher
Technology Education
Charles County Public Schools

Robert Gray, Specialist in Technology Education
Division of Career Technology and Adult Learning
Maryland State Department of Education

The Technology Education Association of Maryland

The Technology Education Symposium Group

The Maryland Association of Technology Education Leaders

State of Maryland
William Donald Schaefer
Governor

The Maryland State Board of Education
Robert C. Embry, Jr.
President, Baltimore 1995
Edward Andrews,
Vice President, College Park 1996
Christopher T. Cross, Washington, DC 1997
George W. Fisher, Sr., Denton 1997
Christopher E. Grant, Baltimore 1996
Marvin E. Jones, Glen Burnie 1995
Elmer B. Kaelin, Hagerstown 1995
Rose LaPlaca, Mitchellsville 1994
Joan C. Maynard, Linthicum Heights 1996
Harry D. Shapiro, Baltimore 1997
Edmonia T. Yates, Baltimore 1994
Allison C. Cole
Student Member, Severna Park 1994
Nancy S. Grasmick
State Superintendent of Schools
A. Skipp Sanders
Deputy State Superintendent for Administration
Joan Palmer
Deputy State Superintendent for School Improvement Services
Katharine M. Oliver
Assistant State Superintendent
Division of Career Technology and Adult Learning
Lynne M. Gilli
Chief, Program Development & Operations Branch
Division of Career Technology and Adult Learning
Gerald F. Day
Chief, Program Enrichment Services
Division of Career Technology and Adult Learning
M. Hazel Outing
Chief, Instructional Services Section
Division of Career Technology and Adult Learning

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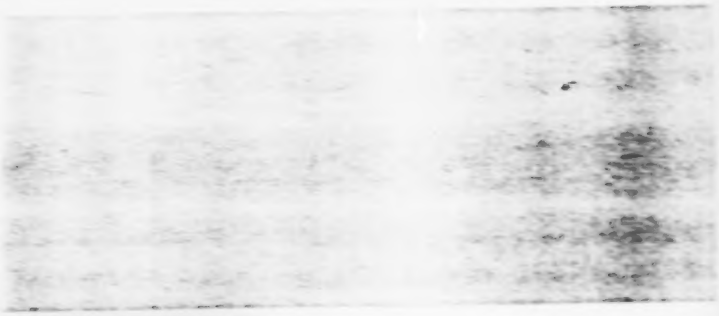
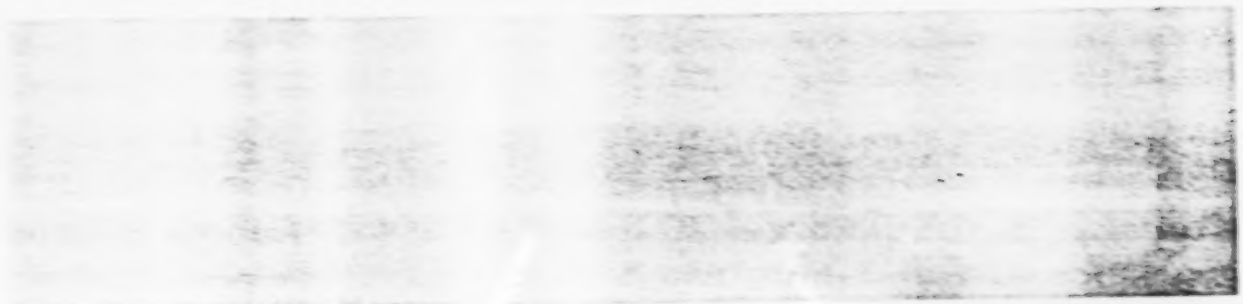


FOREWORD

The State of Maryland has taken the lead, nationally, in addressing the issue of technological literacy. Through the establishment of high school graduation requirements in technology education, we have committed ourselves to providing educational experiences that will enable students to interact successfully with technology, to assess the impact of technology on everyday life, and to apply conceptual knowledge in order to solve problems.

Technology is the application of knowledge, tools, and skills to solve practical problems and extend human capabilities. It is essential that students gain an insight into and an understanding of the technological nature of society. Students must be taught that technologies spring from the human abilities to reason, solve problems, and create. Since these abilities form an integral part of our technological society, they should be developed in all students, regardless of their educational and career goals.

Nancy S. Grasmick
State Superintendent of Schools



INTRODUCTION

A Statement of Purpose

Technology Education: A Maryland Curricular Framework is designed to assist administrators and teachers in planning, developing, and implementing technology education programs. It provides a philosophical foundation and a broad outline from which educators may construct comprehensive school technology education programs. The materials presented will aid local school systems as they engage in the following activities:

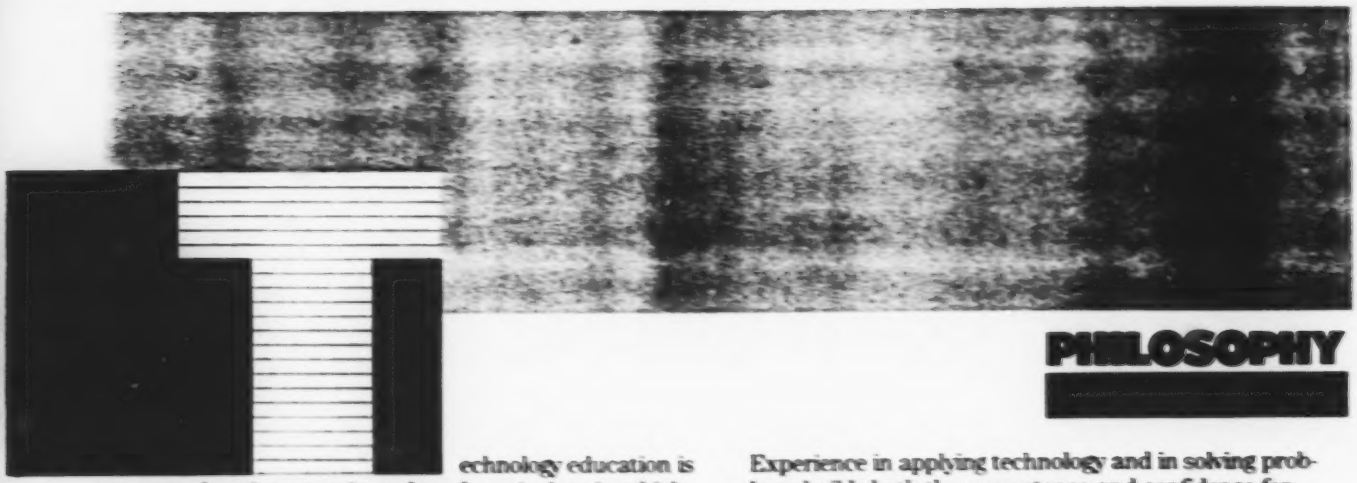
Planning local curricula.
Developing a local philosophy.
Defining a local scope and sequence.
Evaluating the extent to which the goals and subgoals are contained in current curricular offerings.
Identifying needed curricular content and instructional strategies.

This document is organized into the following sections:

1. The Philosophy - This section defines the nature of technology education and describes its relationship to society, the learner, and the school curriculum.
2. What is Technology?
3. What is Technological Literacy?
4. What is Technology Education?
5. Vision for Technology Education
6. Technology Education Learner Outcomes
7. Technology Education Goals and Subgoals - These broad statements of desired outcomes, which are derived from the philosophy, bring direction and clarity to the Learner Outcomes.
8. Technology Education Expectancies - These statements specify the expected behaviors within each subgoal.
9. Illustrative Objectives - These sample objectives show how goals and subgoals may be treated at different instructional levels.
10. Curriculum Development & Assessment - This section describes how to develop and use goals, subgoals, and expectancies in the preparation of technology education scopes, sequences, and instructional units.

Technology Education provides each student with the requisite social, academic, and technical skills essential for success in the complex era of the 21st Century.

Merrill Oaks (D.T.E.)
Washington State University



PHILOSOPHY

Technology education is a comprehensive, experience-based curriculum in which students learn about technology — its evolution, systems, techniques, utilization, and social and cultural significance. It develops "technological literacy" by dealing with the ways in which ingenuity, processes, materials, devices, science, and mathematics are applied for solving problems to meet our needs and desires.

A central role of education is to offer a curriculum that provides students with basic understandings and skills needed to function effectively in society. Our democratic society is characterized by rapidly advancing technological developments. It is absolutely necessary for all people to understand technology if they are to function as informed voters, productive workers, and wise consumers of technological products and services.

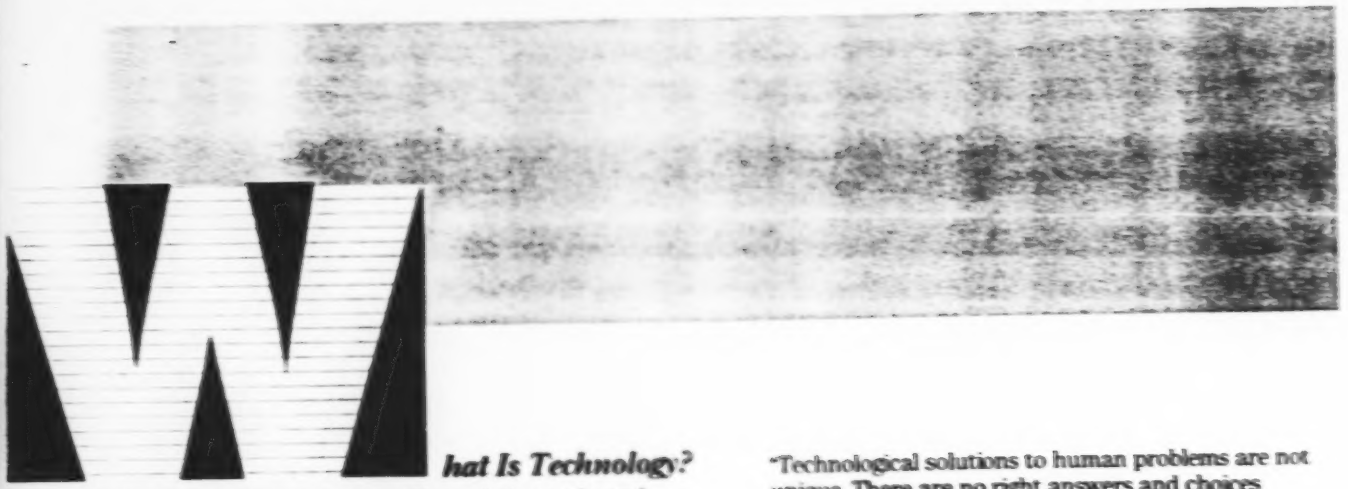
Technologies spring from the human abilities to reason, solve problems, create, construct, and use materials imaginatively. Since these abilities are an integral part of our technological society, they must be developed in all students, regardless of their educational and career goals.

Experience in applying technology and in solving problems builds both the competence and confidence for effective interaction with technology. An understanding of the applications and functioning of technology systems is important for decision making in the arenas of career, home, personal affairs, and government.

In today's high-tech society, all students should become technologically literate in order to become wise decision makers. Through experiences in a "hands-on", cooperative environment using a systematic, problem-solving approach, students should exhibit an understanding of the nature of technology, major technology systems, and the resources used in technology. Through the application of technical skills, knowledge, and processes, students should be able to solve problems in a systematic fashion. Coupled with sound work values, attitudes, and habits that include the recognition and pursuit of quality; these skills should enable students to become wise consumers, productive members of our community, and contributors to the forces of change that shape our world.

The study of technological systems should be used as a basis for providing integrated and holistic learning.

National Science Board
Educating Americans for the 21st Century



What Is Technology?

Technology is the application of knowledge, tools, and skills to solve practical problems and extend human capabilities.

American Association for the Advancement of Science (1989)
Technology — Report of the Project 2061, Phase I Technology Panel

What Is Technological Literacy?

Technology is a significant human phenomenon and pervasive force in the modern world. We must interact with it daily. Technology so impacts our decisions in the arenas of career, home, personal affairs, and government that "technological literacy" has been called a new basic in education.

> "Technological literacy needs to be a part of general literacy and 'numeracy.' In a sense we are speaking of 'basics' in education, and we are identifying the knowledge and understanding of technology as basic. Technological literacy is quite different from scientific literacy and mathematical literacy. An understanding of scientific and mathematical concepts doesn't automatically result in an understanding of technology." (p.73)

National Science Board (1983)
Educating Americans for the 21st Century

Technological literacy is the ability to interact successfully with technology, to assess the impacts of technology on everyday life and make appropriate decisions, and to apply conceptual knowledge in order to solve problems. To individuals, these abilities are a great asset. To our state and nation, these abilities are essential if we are to remain competitive in the world market. We must provide our students with technological literacy for future success, the well-being of our communities, and our nation's pre-eminence.

> "Technological solutions to human problems are not unique. There are no right answers and choices must be made. It is vital that these choices be informed and value-based. A major question about this technical world is 'Who will develop and control the technologies so that they can best serve all citizens?' In the broadest sense, the answer has to be — for a democratic society — a technically literate citizenry." (p.2)

American Association for the Advancement of Science (1989)
Technology: A Project 2061 Panel Report

What Is Technology Education?

Technology Education is an integrated, experienced-based instructional program designed to prepare a population that is knowledgeable about technology — its evolution, systems, techniques, utilization, and social and cultural significance. It results in the application of mathematics and science concepts in technology systems. Students discover, create, solve problems, and construct by using a variety of tools, machines, materials, processes, and computer systems.

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Vision For Technology Education

An integral part of the program of studies in Maryland's schools, Technology Education is a new basic for all students. It is experience-based and involves the application of mathematics and science concepts in technology systems. There is extensive student involvement with problem solving laboratory activities that are rich with hands-on, multi-sensory experiences. Students work individually and in teams as they learn about technology —its evolution, systems, techniques, utilization, and social and cultural significance. Students learn how to utilize and interact with technology; and to live adaptively in a rapidly changing, highly technological society.

Technology Education programs are among the first to demonstrate an integrated approach to learning. Interdisciplinary teams of teachers train and work together for cross-curriculum planning and integrated delivery of instruction. Technology Education is taught using a collaborative approach in which groups of students interact with teachers of mathematics, science, social studies, language arts, technology, and other disciplines. Cooperative learning, ingenuity challenges, modular activities, and computer-assisted instruction are some of the approaches used to provide students with hands-on learning experiences in which they can demonstrate established learning outcomes.

The Technology Education program challenges all students to acquaint themselves with their technological environment so they are better prepared to make informed decisions about their lives and eagerly participate in controlling their own destiny. Programs recognize, capitalize on, and build on the individual's inherent potential for reasoning and problem solving, for imagining and creating, for constructing and expressing by using implements and materials from which technologies spring.

The resources for program implementation are adequate to assure the fulfilling of program potentials and meeting of student needs. Staff development experiences support teachers as they employ appropriate teaching-learning strategies. Instructional materials in a variety of forms facilitate student achievement of the valued outcomes. Laboratories are appropriately equipped to accommodate student learning through active, hands-on, multi-sensory interaction with significant technology systems. School and business/industry partnerships play a role in developing and making available these valuable resources. Thus, Technology Education is a fundamental curriculum for all students, regardless of learning level, career choices, or life aspirations.

The study of technology is essential for an understanding of culture, just as a comprehension of the material basis of social life is indispensable to those concerned with human group behavior.

M.J. Herskovitz (1960)
Man and His Works

TECHNOLOGY EDUCATION LEARNER OUTCOMES

The technology education learner outcomes listed below describe what students should be able to do, think, and feel as the result of a technology education experience. The framework is based on learner outcomes established by the Maryland State Department of Education. The framework is composed of goals and subgoals from which activities and lessons are to be developed.

Application of Technology Systems

Students will demonstrate knowledge and skills regarding diverse technology systems, including their functioning and applications.

Nature, Impacts, and Evolution of Technology

Students will demonstrate knowledge of the nature of technology, and the relationships and impacts among technological achievement, the environment, the advancement of science, the individual, and society. The context for this knowledge shall be historical, current, and futuristic.

Problem Solving Using Technology

Students will demonstrate the ability to solve problems with technology using a systems approach, higher-order thinking skills, individual and collaborative ingenuity, and a variety of resources including information, tools and materials.

Informed Decisions About Technological Issues

Students will make ethical decisions about technological issues, including the development and use of technology and technology resources.

Use of Technology Resources

Students will demonstrate in an experiential setting the safe, effective, and creative use of technology resources — including tools, machines, and materials — in performing technological processes.

Application of Science, Mathematics and Other Areas

Students will apply science, mathematics, language arts, social studies, and technological concepts to solve practical problems and extend human capabilities.

Career Information

Students will apply knowledge of and perform tasks representative of technology-based careers, including engineers, technologists, technicians, and craftspersons.

Multicultural and Gender Diversity

Students will recognize the multicultural and gender diversity included in past, present, and future uses of technology.

There must be someplace in the school where the students can put all the parts (academic disciplines) together in the context of reality and the world beyond the school. That place is Technology Education.

Donald Maley, Professor Emeritus
The University of Maryland

GOAL 1

Applications of Technology Systems

Students will demonstrate knowledge and skills regarding diverse technology systems.

Subgoals

1.1 Students demonstrate knowledge and skills related to the applications of a variety of technology systems.

1.2 Students demonstrate knowledge and skills related to the functioning of a variety of technology systems.

Students must be prepared to understand technological innovation, the productivity of technology, the impact of the products of technology on the quality of life, and the need for critical evaluation of societal matters involving the consequences of technology.

National Science Board (1983)
Educating Americans for the 21st Century

GOAL 2

Nature, Impacts, and Evolution of Technology

Students will demonstrate knowledge of the nature of technology, including its impacts and evolution.

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Subgoals

2.1 Students demonstrate knowledge of the nature and characteristics of technology.

2.2 Students demonstrate knowledge of the relationships and impacts among technological achievement, the environment, the advancement of science, the individual, and society.

2.3 Students demonstrate knowledge of the evolution of technology.

Technology Education enables the individual to look, listen, formulate, and reflect upon ideas and systems that shape the world in which they live.

John Vaglia, Associate Dean
East Tennessee State University

GOAL 3

Problem Solving Using Technology

Students will demonstrate the ability to solve problems with technology.

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Subgoals

3.1 Students utilize a systems approach in solving technological problems.

3.2 Students employ higher-order thinking skills for solving technological problems.

3.3 Students utilize collaborative and individual ingenuity for solving technological problems.

3.4 Students utilize a variety of resources and processes to solve technological problems.

3.5 Students demonstrate the ability to work as a team member in the solution of technological problems.

Technology Education is the "general education" of the world of technology. Technology Education is the "know-how" for the future.

Arthur J. Rosser
Central Missouri State University

GOAL 4

Informed Decisions About Technological Issues

Students will make ethical decisions about technological issues.

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Subgoals

4.1 Students identify problems resulting from technological achievements.

4.2 Students utilize resources to develop a knowledge base for making informed decisions about technological issues.

4.3 Students assess the impact of technology on the individual, society, and the environment.

4.4 Students make judgments about technological issues.

A technologically literate populace is necessary if citizens are to apply in a responsible manner their values and judgments in the control and use of technology.

J.R. Johnson (1990)
"The Urgent Need for Broad-based Technology Education" *TIES*

GOAL 5

Use of Technology Resources

Students will demonstrate in an experiential setting the safe, effective, and creative use of technology resources — including tools, machines, and materials.

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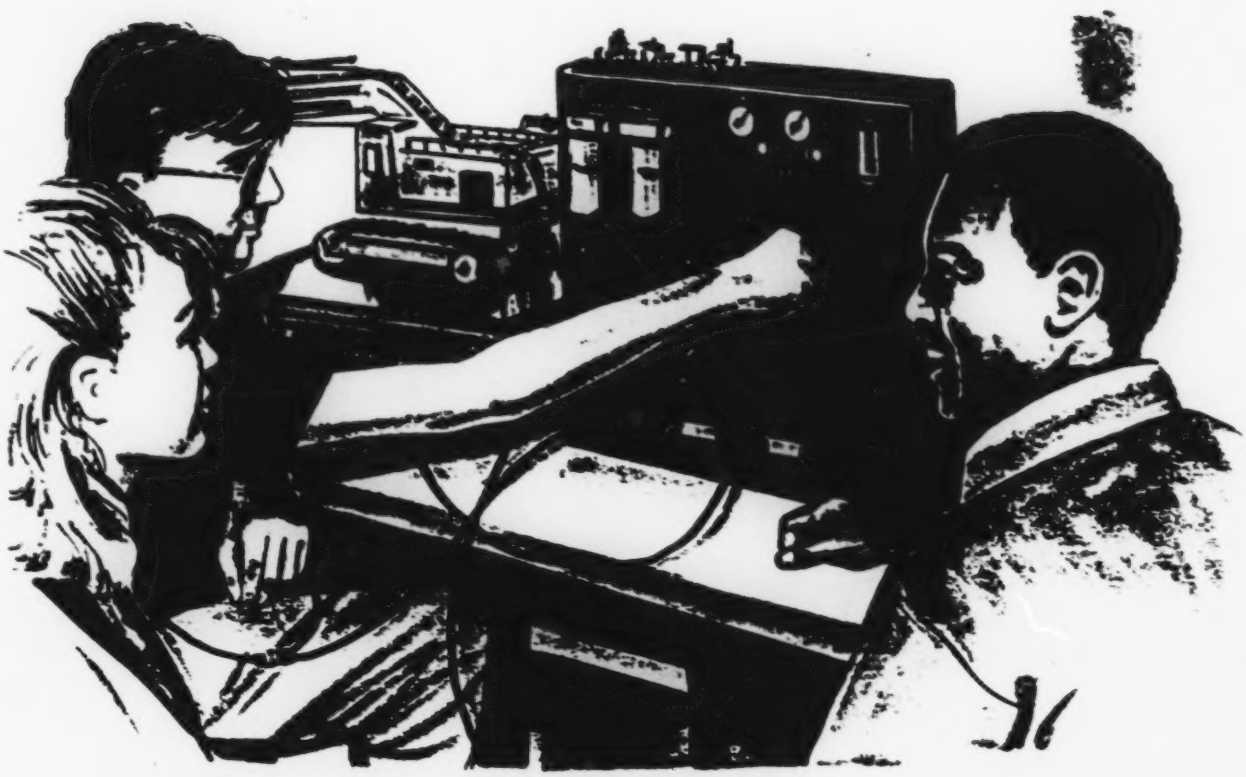
Subgoals

5.1 Students create technology for human purposes through the skillful use of technology resources.

5.2 Students use technology resources in a safe and responsible manner.

5.3 Students demonstrate ingenuity and creativity in the use of technology resources.



. . .the corresponding merit of a technical education is that it follows our deep natural instinct to translate thought into manual skill, and manual activity into thought.

A.N. Whitehead (1953)
Aims of Education

GOAL 6

Application of Science, Mathematics, and Other Areas

Students will apply science, mathematics, language arts, social studies, and technological concepts to solve practical problems and extend human capabilities.

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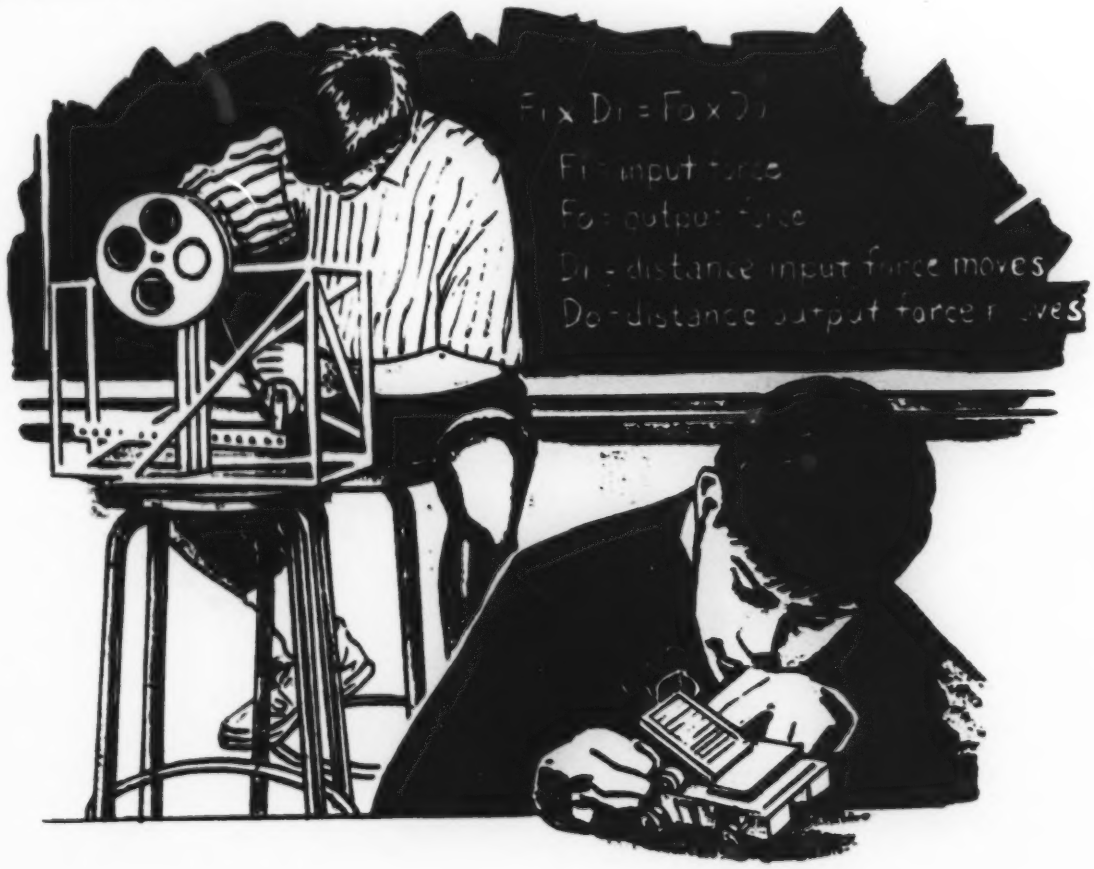
Subgoals

6.1 Students apply mathematical concepts, processes, and skills to solve technological problems.

6.2 Students apply scientific concepts, processes, and skills to the solution of technological problems.

6.3 Students utilize communication skills in the solution of technological problems.

6.4 Students apply social studies concepts, processes, and skills to explore the impacts of technology.



Technology topics need to be integrated into the present curriculum. This includes science and mathematics classes, technology education, social studies, and the language arts, and art and music.

National Science Board (1983)
Educating Americans for the 21st Century

GOAL 7

Career Awareness and Exploration

Students will apply knowledge of and perform tasks representative of technology-based careers including engineers, technologists, technicians, and craftspersons.

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Subgoals

7.1 Students identify personal interests and abilities related to technology-based careers.

7.2 Students investigate educational opportunities and requirements related to technology-based careers.

7.3 Students investigate career opportunities, trends, and requirements related to technology-based careers.

7.4 Students identify and demonstrate factors for employability and advancement related to technology-based careers.

7.5 Students perform work tasks representative of those done by engineers.

7.6 Students perform work tasks representative of those done by technologists.

7.7 Students perform work tasks representative of those done by technicians.

7.8 Students perform work tasks representative of those done by craftspersons.

Technology Education prepares people to actively participate in society as private citizens and productive workers.

R. Thomas Wright
Ball State University

GOAL 8

Multicultural and Gender Diversity

Students will recognize the multicultural and gender diversity inherent in the evolution of technology.

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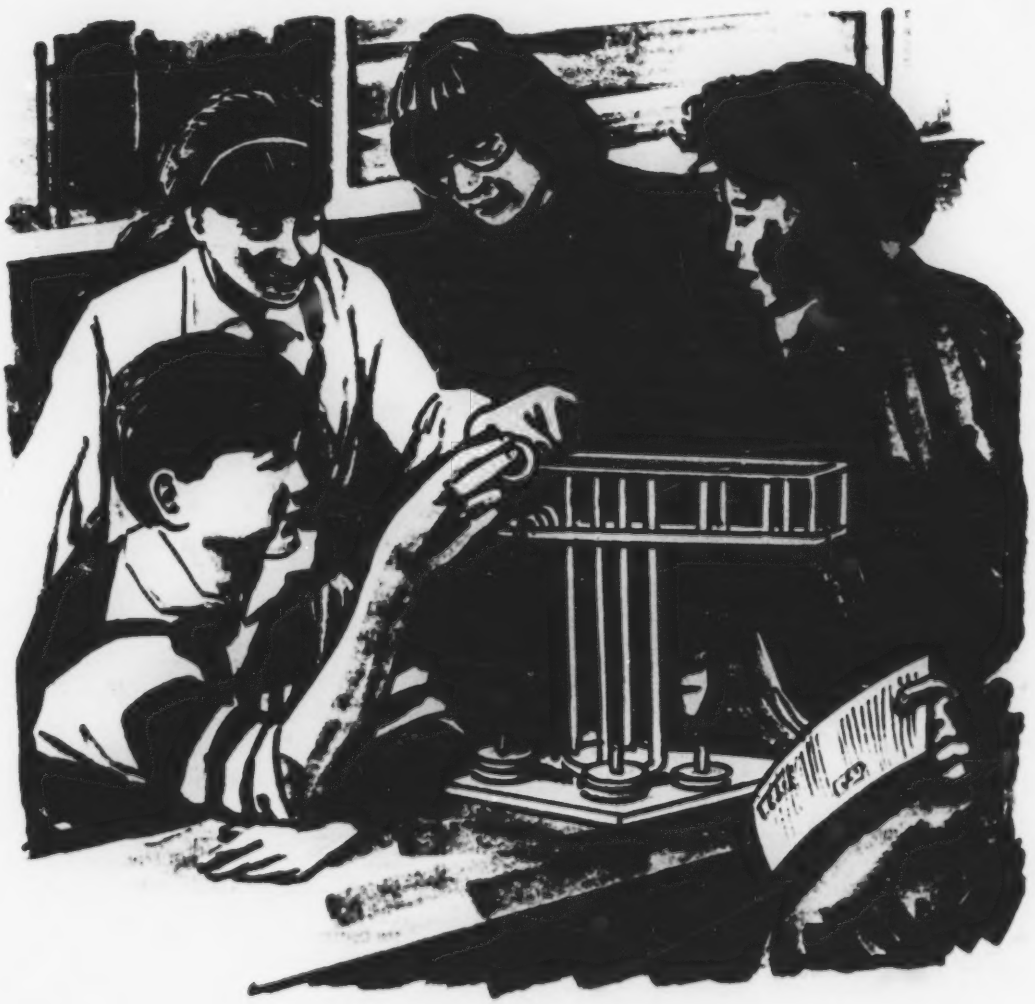
Subgoals

8.1 Students recognize the importance of the historical contributions of men and women of different cultures to the advancement of technology.

8.2 Students understand the current and future implications of multicultural contributions to the advancement of technology.



Scientists study the world as it is, engineers create the world that never has been.

Theodore von Karman

EXPECTANCIES

GOAL 1 *Applications of Technology Systems* — Students will demonstrate knowledge and skills regarding diverse technology systems.

Subgoal 1.1 Students demonstrate knowledge and skills related to the applications of a variety of technology systems.

The learner:

1.1.1 recognizes that people have created technology systems to satisfy basic needs and desires.
1.1.2 defines a technology system as a combination of elements acting together to convert resources into devices and systems which enhance the well-being of humans.
1.1.3 identifies the human enterprises and institutions that utilize technology including: manufacturing, construction, transportation, communication, health care, agriculture, commerce, law enforcement, education, family and household, etc.
1.1.4 describes the applications of representative modern technology systems and devices.
1.1.5 creates and applies technology systems.

Subgoal 1.2 Students demonstrate knowledge and skills related to the functioning of a variety of technology systems.

The learner:

1.2.1 analyzes the functioning of technology systems using a technology systems model.
1.2.2 identifies technology systems as having inputs, a process, outputs, and feedback.
1.2.3 demonstrates knowledge of the role of controls in technology systems.
1.2.4 identifies the resources used to create technology systems, which include: people, information, tools and machines, materials, energy, capital, and time.
1.2.5 demonstrates knowledge of the core technologies from which all technology sytems are derived, which include: mechanical technology, structural technology, fluid technology, electrical technology, electronics technology, optical technology, thermal technology, bio technology, and materials technology.
1.2.6 utilizes processes to produce a services output.
1.2.7 utilizes processes to produce a goods output.

GOAL 2 *Nature, Impacts, and Evolution of Technology* — Students will demonstrate knowledge of the nature of technology, including its impacts and evolution.

Subgoal 2.1 Students demonstrate knowledge of the nature and characteristics of technology.

The learner:

2.1.1 recognizes that technology results from human ingenuity.
2.1.2 recognizes that technology requires resources.
2.1.3 recognizes the potential of technology for positive and negative impacts.
2.1.4 recognizes that technology determines opportunities and requirements for careers.
2.1.5 appreciates the contributions of diverse cultures to the advancement of technology.
2.1.6 recognizes that technology is constantly changing and, therefore, requires life-long learning.
2.1.7 recognizes the accelerating rate of technological change.
2.1.8 explains that complex technology systems develop from more simple technologies.

Whatever one man is capable of conceiving, other men will be able to achieve.

Jules Verne

Subgoal 2.2 Students identify the relationships and impacts among technological achievement, the environment, the advancement of science, the individual, and society.

The learner:

2.2.1 recognizes technology's ability to relieve humans of physically demanding work.
2.2.2 recognizes the need to combine technologies in solving problems.
2.2.3 identifies the role of current technology in producing new and more powerful technologies.
2.2.4 identifies the impacts of technological achievement on the environment.
2.2.5 recognizes the relationships between technological achievement and the advancement of science.
2.2.6 recognizes the relationships between technological achievement and its impact on society.
2.2.7 describes the importance of engineers, technologists, technicians, and craftspersons in the modern world.
2.2.8 demonstrates knowledge of historical and current technological achievements.
2.2.9 investigates and reports on emerging and futuristic technologies.

Subgoal 2.3 Students demonstrate knowledge of the evolution of technology.

The learner:

2.3.1 identifies and describes the impact of major technological achievements made during the Pre-Agriculture Age.
2.3.2 identifies and describes the impact of major technological achievements made during the Agricultural Age.
2.3.3 identifies and describes the impact of major technological achievements made during the Industrial Age.
2.3.4 identifies and describes the impact of major technological achievements made during the Information Age.

GOAL 3 *Problem Solving Using Technology* — Students will demonstrate the ability to solve problems with technology.

Subgoal 3.1 Students utilize a systems approach in solving technological problems.

The learner:

3.1.1 recognizes formal and informal approaches to problem solving.
3.1.2 employs a systematic model for problem solving.
3.1.3 designs and develops technology systems.
3.1.4 constructs prototypes or mock-ups of technology systems.
3.1.5 tests, analyzes, evaluates, and refines solutions to technological problems.

Subgoal 3.2 Students employ higher-order thinking skills for solving technological problems.

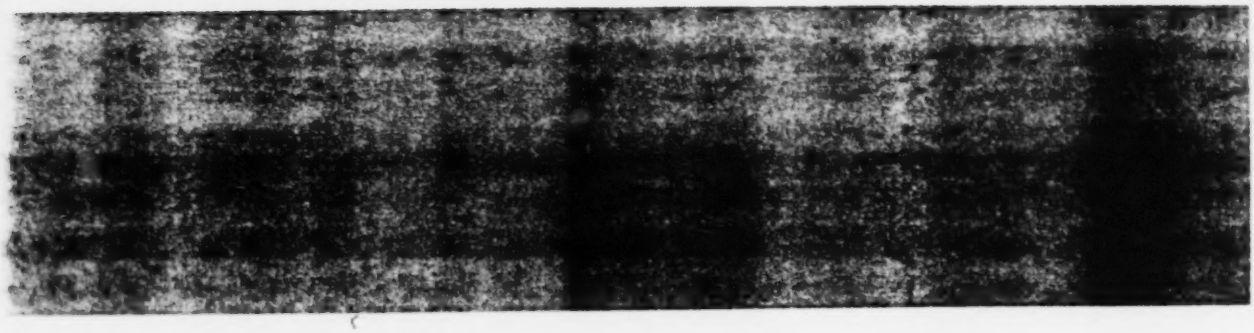
The learner:

3.2.1 uses qualitative and quantitative data to make judgments related to technological problems and solutions.
3.2.2 utilizes analysis in problem solving through the breakdown of the problem into constituent elements or parts for enhanced understanding.
3.2.3 demonstrates the ability to synthesize (combine) technological elements to produce an enhanced solution to a problem.

Subgoal 3.3 Students utilize collaborative and individual ingenuity for solving technological problems.

The learner:

3.3.1 combines resources in innovative ways to solve technological problems.
3.3.2 joins with others in developing solutions to problems.



Subgoal 3.4 Students utilize a variety of resources and processes to solve technological problems.

The learner:

3.4.1 identifies the resources that can be utilized to solve technological problems: people, tools, machines, information, materials, energy, capital, and time.
3.4.2 selects appropriate resources.
3.4.3 designs and constructs prototypes and mock-ups of technology systems
3.4.4 tests, analyzes, evaluates, and refines technology systems.

Subgoal 3.5 Students demonstrate the ability to work as a team member in the solution of technological problems.

The learner:

3.5.1 develops appropriate social skills.
3.5.2 demonstrates communication skills.
3.5.3 applies management skills to the solution of a problem by a team.
3.5.4 utilizes organizational skills.
3.5.5 demonstrates leadership ability.
3.5.6 demonstrates a willingness to compromise in order to meet the group's objectives.

Technology Education should emphasize the posing and solving of problems, increasingly complex, as students move from kindergarten through the twelve grades.

J.R. Johnson (1990)
"The Urgent Need for Broad-Based Technology Education" *TIES*

GOAL 4 *Informed Decisions About Technological Issues* — Students will make ethical decisions about technological issues.

Subgoal 4.1 Students identify problems resulting from technological achievements.

The learner:

4.1.1 recognizes the responsibility of citizens to evaluate technological achievements.
4.1.2 defines a technological problem in a clear and precise manner.
4.1.3 identifies factors contributing to a technologically created problem.

Subgoal 4.2 Students utilize resources to develop a knowledge base for making informed decisions about technological issues.

The learner:

4.2.1 uses knowledge of science, mathematics, language arts, social studies, and technological concepts to formulate positions on issues related to technology.
4.2.2 employs the language, instruments, and materials of science for collecting and organizing information.
4.2.3 analyzes technology systems utilizing a systems model.
4.2.4 investigates library resources for information regarding technological issues.
4.2.5 consults people, agencies, and enterprises for information regarding technological issues.
4.2.6 demonstrates a logical procedure for making decisions.
4.2.7 identifies and applies appropriate forecasting techniques including predicting and extrapolating.

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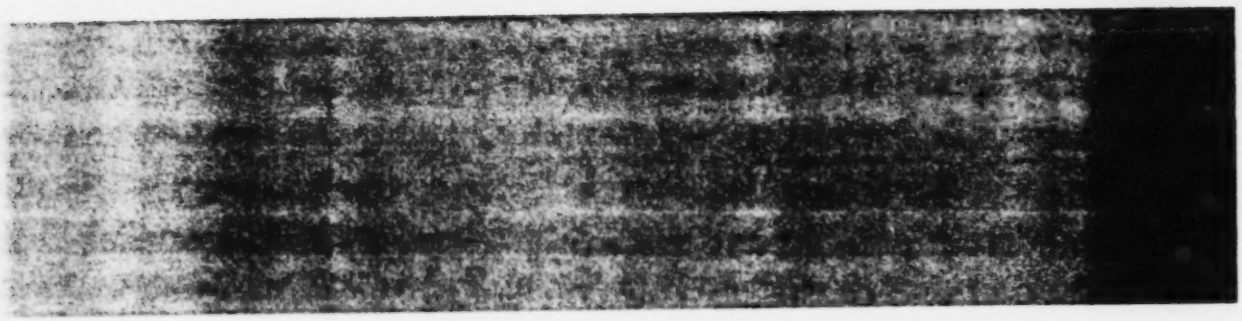


Subgoal 4.3 Students assess the impact of technology on the individual, society, and the environment.

The learner:

4.3.1 examines the impact of technology on individual citizens.
4.3.2 describes the societal impacts of technology.
4.3.3 assesses the environmental impacts of technology.
4.3.4 understands that technological systems are interrelated with social, economic, and environmental systems.
4.3.5 evaluates ethical issues related to the application of technology in society.

Subgoal 4.4 Students make judgments about technological issues.

The learner:

4.4.1 participates in ethical decision-making regarding the selection and application of technology.
4.4.2 recognizes the need for compromises and trade-offs in solving technological problems.
4.4.3 states a position on a technological issue.
4.4.4 justifies a stated position using appropriate resources.

Technology Education provides a commitment to a time-honored goal, this, to merge the realities of life in a technological society with the educational system.

Donald P. Lauda,
California State University,
Long Beach

GOAL 5 *Use of Technology Resources* — Students will demonstrate in an experiential setting the safe, effective, and creative use of technology resources — including tools, machines, and materials.

Subgoal 5.1 Students create technology for human purposes through the skillful use of technology resources.

The learner:

5.1.1 identifies people, information, materials, tools and machines, energy, capital, and time as the resources for technology.
5.1.2 selects and uses resources in the solution of a problem.
5.1.3 uses tools and equipment to process materials.
5.1.4 constructs prototypes or mock-ups of technology systems.
5.1.5 tests, analyzes, evaluates, and refines solutions to technological problems.

Subgoal 5.2 Students use technology resources in a safe and responsible manner.

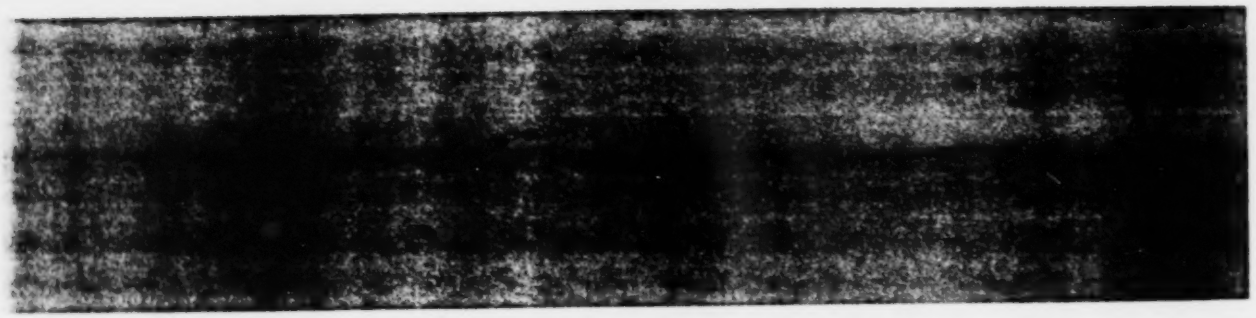
The learner:

5.2.1 interacts safely with technology systems and devices.
5.2.2 develops an appreciation for the maintenance of a life-supporting environment.
5.2.3 follows established safety procedures in laboratory activities.
5.2.4 encourages others to interact safely with technology.

Subgoal 5.3 Students demonstrate ingenuity and creativity in the use of technology resources.

The learner:

5.3.1 modifies devices or processes to solve technological problems.
5.3.2 identifies new uses for existing devices and processes.
5.3.3 invents new devices or processes to solve technological problems.



GOAL 6 *Application of Science, Mathematics, and Other Areas* — Students will apply science, mathematics, language arts, social studies, and technological concepts to solve practical problems and extend human capabilities.

Subgoal 6.1 Students apply mathematical concepts, processes, and skills to solve technological problems.

The learner:

6.1.1 develops appreciation of mathematics as a symbolic language that serves to simplify complex problems.
6.1.2 uses appropriate formulas to aid in finding solutions to problems.
6.1.3 uses mathematic techniques to describe.
6.1.4 uses mathematic techniques to predict.
6.1.5 uses technology to extend the application of mathematics.
6.1.6 analyzes technological systems using mathematical techniques.

Subgoal 6.2 Students apply scientific concepts, processes, and skills to the solution of technological problems.

The learner:

6.2.1 applies the knowledge of science — its concepts, theories, principles, and laws — to the solution of technological problems.
6.2.2 employs the language, instruments and materials of science for collecting, organizing, and communicating information.
6.2.3 identifies science concepts, theories, principles, and laws that pertain to technology systems.
6.2.4 uses scientific methods to gain new understandings that can be applied to the solution of technological problems.

Subgoal 6.3 Students utilize communication skills in the solution of technological problems.

The learner:

6.3.1 states questions and working assumptions in a concise manner.
6.3.2 utilizes listening skills for receiving information.
6.3.3 explains methods and procedures used in the problem solving process.
6.3.4 communicates ideas through drawings.
6.3.5 writes reports that are supported by data and references.
6.3.6 orally presents reports which are supported by data and references.
6.3.7 conveys accurately the results of technological investigations.

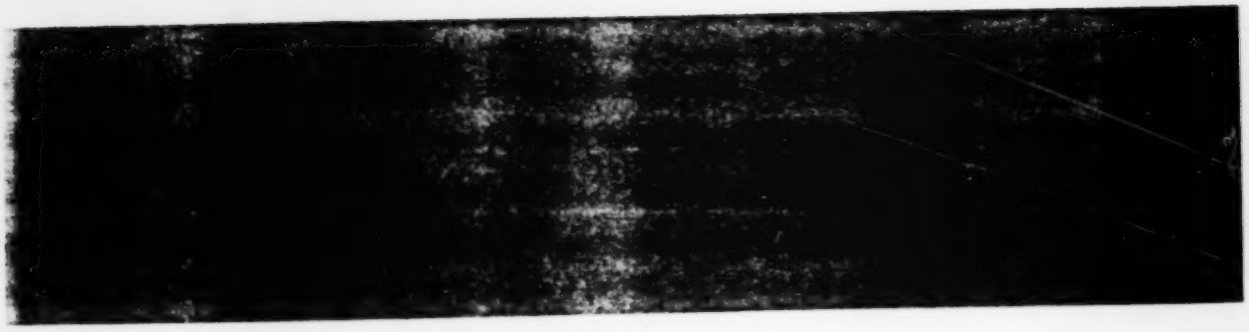
Subgoal 6.4 Students apply social studies concepts, processes, and skills to explore the impacts of technology.

The learner:

6.4.1 recognizes the impact of technology systems upon our world: including the economic, political, and social dimensions.
6.4.2 describes changes in society due to technological developments.
6.4.3 recognizes the need to examine the societal impact of technological development.

The mathematics and science now offered to our young people could be greatly enriched if we were to incorporate a technological content.

A Nation at Risk
National Commission on Excellence



GOAL 7 *Career Awareness and Exploration* — Students will apply knowledge of and perform tasks representative of technology-based careers including engineers, technologists, technicians, and craftspersons.

Subgoal 7.1 Students identify personal interests and abilities related to technology-based careers.

The learner:
7.1.1 recognizes creative talents.
7.1.2 explores aptitude for innovativeness.
7.1.3 determines aptitude for working as a member of a problem-solving team.
7.1.4 performs tasks utilized in the creation and application of technological systems including: designing, constructing, testing, analyzing, evaluating, and refining.

Subgoal 7.2 Students investigate educational opportunities and requirements related to technology-based careers.

The learner:
7.2.1 describes the educational requirements for engineers, technologists, technicians, and craftspersons.
7.2.2 describes the educational opportunities for engineers, technologists, technicians, and craftspersons.

Technology Education provides people with self-educative skills such as problem-solving, critical thinking, and analytical abilities.

Walter B. Waetjen, President Emeritus
Cleveland State University

Subgoal 7.3 Students investigate career opportunities, trends, and requirements related to technology-based careers.

The learner:
7.3.1 describes the work performed by engineers, technologists, technicians, and craftspersons.
7.3.2 investigates trends in technology-related careers.
7.3.3 describes the requirements for engineers, technologists, technicians, and craftspersons.

Subgoal 7.4 Students identify and demonstrate factors for employability and advancement related to technology-based careers.

The learner:
7.4.1 reasons and solves problems.
7.4.2 reads and understands written information.
7.4.3 uses mathematics skills to measure and solve problems.
7.4.4 speaks and writes in a manner that others can understand.
7.4.5 recognizes and acts on one's rights, responsibilities, and opportunities.
7.4.6 uses technology, adapts to its changes, and makes decisions about it.
7.4.7 works respectfully and cooperatively with others.
7.4.8 develops high standards for personal performance.

Subgoal 7.5 Students perform work tasks representative of those done by engineers.

The learner:
7.5.1 recognizes problems or conditions that need improvement.
7.5.2 uses knowledge, skill, and innovative thought to produce one or more acceptable solutions.
7.5.3 uses mathematics and science concepts and skills to create functional devices, systems, and processes which enhance the well-being of humans.

Subgoal 7.6 Students perform work tasks representative of those done by technologists.

The learner:
7.6.1 applies scientific and engineering knowledge and skills to support engineering activities.
7.6.2 designs production systems.
7.6.3 develops design components.
7.6.4 manages design operations.
7.6.5 supervises construction, maintenance, and production activities.

Subgoal 7.7 Students perform work tasks representative of those done by technicians.

The learner:
7.7.1 performs tests of mechanical, optical, hydraulic, pneumatic, electrical, thermal, and electronic/digital components or systems.
7.7.2 prepares technical reports.
7.7.3 obtains, selects, compiles, and uses technical information from computer-controlled measuring, recording, and display instruments.
7.7.4 uses computers to analyze and interpret information.

Subgoal 7.8 Students perform work tasks representative of those done by craftspersons.

The learner:
7.8.1 performs equipment checks and maintenance.
7.8.2 carries out plans and designs of engineers.
7.8.3 sets up scientific experiments.

Technology Education is the one discipline that directs its total effort to contributing to technological literacy.

James M. Benson, President
International Technology
Education Association

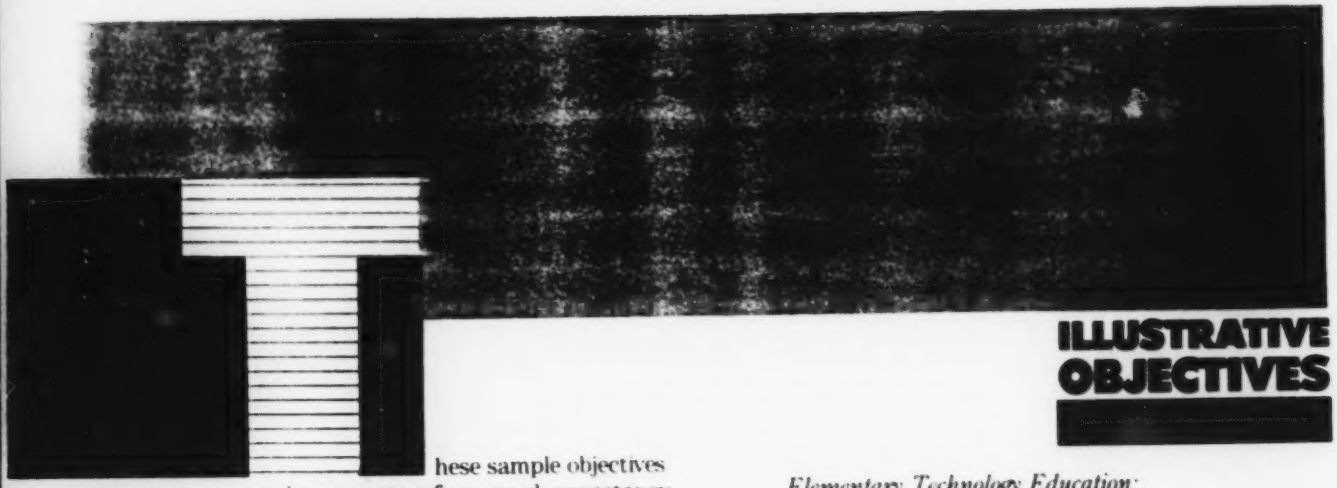
GOAL 8 *Multicultural and Gender Diversity* — Students will recognize the multicultural and gender diversity inherent in the evolution of technology.

Subgoal 8.1 Students recognize the importance of the historical contributions of men and women of different cultures to the advancement of technology.

The learner:
8.1.1 develops an awareness of technological contributions of men and women of different cultures.
8.1.2 identifies men and women of different cultures who have solved technological problems and enhanced human capabilities.
8.1.3 researches and reports on women and minority inventors.
8.1.4 uses diverse role models to expand career opportunities.

Subgoal 8.2 Students will understand the current and future implications of multicultural contributions to the advancement of technology.

The learner:
8.2.1 develops an awareness of the importance of current and future technological contributions of men and women of different cultures.
8.2.2 identifies men and women of different cultures who are solving technological problems and enhancing human capabilities.



ILLUSTRATIVE OBJECTIVES

These sample objectives represent a way to incorporate a framework expectancy into a local technology education curriculum. They are organized to give sample objectives for four levels: elementary, middle/junior high, high school, and advanced high school technology education. A local school system that chooses to use these illustrative objectives may determine their specific placement and modify them to meet local needs.

GOAL 1 Students will demonstrate knowledge and skills regarding diverse technology systems.

Subgoal 1.1 Students demonstrate knowledge and skills related to the applications of a variety of technology systems.

Expectancy
The learner:

1.1.1 recognizes that people have created technology systems and devices to satisfy basic needs and wants.

Elementary Technology Education:
During grades K-5 the learner will:
a. identify technological devices.
b. use a technology systems model to describe household technological devices.
c. discuss how technological devices enhance our lifestyle.

Middle/Junior High Technology Education:
During grades 6-8 the learner will:
a. describe several technology systems.
b. use a technology systems model to describe technology systems.
c. describe how technology systems are combined to meet our needs.

High School Technology Education:
During grades 9-12 the learner will:
a. identify technology systems.
b. discuss how technology systems provide for our needs and desires.
c. describe how technology systems are combined to solve problems.

Advanced High School Technology Education:
During grades 9-12 the learner will:
a. discuss how technology systems provide for our needs and desires.
b. describe how technology systems are interrelated.
c. select and combine elements of diverse technology systems to create solutions to unfamiliar problems.

Those who dream by day are cognizant of things which escape those who dream only by night.

Edgar Allan Poe

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CURRICULUM ASSESSMENT AND DEVELOPMENT

PHILOSOPHY

A philosophy is an explicit statement of the beliefs that should direct all aspects of a school system's curriculum. Developing a statement of philosophy allows educators in a system to reach consensus about the nature of the subject matter as it relates to the instructional program. A clear statement of philosophy, therefore, can aid the school system in developing goals, specifying instructional strategies, and assessing programs.

A comprehensive philosophy should begin by addressing the subject matter, its relationship to society, and its relationship to learners. Based upon a synthesis of these elements, a clear position statement should be developed to direct the structuring of the curriculum.

The Subject Matter

This section should describe the subject matter that is to be taught and the disciplines from which the curriculum should be drawn. It should address the underlying premises and values as well as the investigative strategies and processes inherent in these disciplines.

If we want to get serious about using the schools as an agent for maintaining and improving the American standard of living, let's consider placing greater emphasis on technology in schools.

J. M. Atkin
Teach Science for Science Sake: for Global Competitiveness, Try Technology. *TIES* (1991)

Society

Society's needs in relation to the subject matter should be of primary importance when planning a program. This section of the philosophy should describe these needs and how they can be met by a comprehensive curriculum.

The Learner

The system's set of beliefs about the needs of students is stated in this section. These needs include those that are influenced by the external demands of society and those which, if met, would lead to personal fulfillment.

The Curricular Statement

The curricular statement is the culminating section of the philosophy. It synthesizes the needs of society and the learner with the subject matter content to produce a rationale for the curriculum.

DEVELOPING A PHILOSOPHY

In developing a program philosophy it may be useful to review existing philosophy statements from the local, state, and national levels. Implicit beliefs held by the local community should also be identified and considered. Finally, a system-wide consensus should be reached on the key beliefs outlined in the final product.

EXAMPLE OF A LOCAL TECHNOLOGY EDUCATION PHILOSOPHY

Subject Matter

Technology Education is a comprehensive, experienced-based curriculum in which students learn about technology — its evolution, systems, techniques, utilization, and social and cultural significance. It develops "technological literacy" by dealing with the ways in which ingenuity, processes, materials, devices, science, and mathematics are applied for solving problems to meet our needs and desires.

Society

A central role of education is to offer a curriculum that provides students with the basic understandings and skills needed to function effectively in society. Since our democratic society is characterized by rapidly advancing technological developments, it is absolutely necessary for all people to understand technology if they are to function as informed voters, productive workers, and wise consumers of technological products and services.

Learner

Technologies spring from the human abilities to reason, solve problems, create, construct, and use materials imaginatively. Since these abilities are an integral part of our technological society, they must be developed in all students, regardless of their educational and career goals. Experience in applying technology and in solving problems builds both the competence and confidence for effective interaction with technology. An understanding of the applications and functioning of technology systems is important for decision making in the arenas of career, home, personal affairs, and government.

Curriculum

In today's high-tech society all students should become technologically literate in order to become wise decision makers. Through the application of technical skills, knowledge, and processes, students should be able to solve problems in a systematic fashion. Coupled with sound work values, attitudes, and habits, these skills should enable students to become wise consumers, productive members of our community, and contributors to the forces of change that shape our world.

Students must be prepared to understand technological innovation, the productivity of technology, the impact of the products of technology on the quality of life, and the need for critical evaluation of societal matters involving the consequences of technology.

National Science Board (1983)
Educating Americans for the 21st Century

GOALS

Goals are broad, general statements that are derived from the philosophy that determine the curriculum. They set the direction of the program by identifying those learner outcomes that are to be achieved through a comprehensive and effective program.

Since program goals are broad, subgoals may be used to define the major areas covered by each goal. Additional levels of behavioral statements may be written to further specify the expected behaviors within each subgoal.

Developing Goals

Goals should be developed from and thus reflect the system's philosophy. The chosen set of goals should, at minimum, incorporate all of the goals and subgoals from the state while addressing the specific needs of the community and special populations of children.

SCOPE AND SEQUENCE

A scope and sequence is a picture of the entire curriculum from the school system level. It provides a broad overview of the content of the curriculum and illustrates the sequencing of the material from kindergarten through the twelfth grade.

In any scope and sequence it is important that certain key elements be presented for each unit or course; the title or topic, a narrative describing the content, the goals and subgoals to be taught, and the placement of the unit or course within the school program.

Developing and Assessing A Scope and Sequence

The first step for developing a new scope and sequence or modifying an existing one is to review what is currently being taught. To accomplish this it may be helpful to answer the following series of questions about the current scope and sequence.

1. Are the topics covered adequate to meet the desired scope of the program?
2. Is the content and its placement appropriate for the developmental levels of the various types of learners?
3. Are each of the system's goals incorporated into the current scope?
4. Does the sequence follow a logical order and allow for recycling of material when appropriate?

The answers to these questions should be examined and recommendations made for needed changes in the scope and sequence. Once this needs assessment has been completed, the scope and sequence should be revised to reflect the newly developed philosophy and goals.

There are a variety of ways that a sequence can be structured and still meet the recognized needs of a system. The following comprehensive technology education sequence is provided as one example of how this might be done.

EXAMPLE OF A LOCAL TECHNOLOGY EDUCATION SCOPE AND SEQUENCE

The scope and sequence of technology education provides a picture of the entire curriculum from the school system level. It provides a broad overview of the content of the curriculum; and illustrates the sequence of the material from elementary through high school. This document will address:

- elementary school technology education
- middle school technology education
- high school technology education
- advanced high school technology education

Elementary School Technology Education

The purpose of elementary technology education is to develop the students' awareness of technology. The technology education program is not a stand-alone curriculum, but rather is integrated into other courses. It reinforces basic learning through hands-on technology related activities.

Technology Education gives students opportunities to apply their knowledge and understandings from other academic disciplines while solving technical problems.

John H. Lucy, Professor
California University of Pennsylvania

Elementary School Technology Education students will:

1. become aware of the history (evolution) of technology.
2. become aware of the utilization of technology to meet human needs and desires.
3. become aware of the significance or social impacts of technology.
4. learn safe work habits.
5. use tools and materials to fabricate devices to solve problems.
6. utilize written and oral communication skills.
7. develop cooperative work habits.
8. develop problem-solving skills.

Middle/Junior High School Technology Education

Technology education at the middle/junior high school level is characterized by the term "exploration." At this level, students should be involved in broad, introductory experiences in communication, construction, manufacturing, transportation, and bio-related technologies. It is recommended that all students study technology at this level regardless of educational and career goals. This is because technology influences every consumer, worker, and citizen in our society. Every person should be able to understand and use technology.

Middle School/Junior High School Technology Education students will:

1. define technology.
2. explore technology systems.
3. utilize a problem-solving strategy to solve technology-related problems.
4. develop a positive self image by meeting success in hands-on experiences.
5. develop skills in the safe use and operation of basic tools, machines, materials, and processes of technology.
6. identify his/her talents, abilities, and interests in technological fields.
7. develop cognitive (mental), psychomotor (physical), and affective (ethical) problem-solving skills by researching and developing, designing, producing, operating, and analyzing technology systems.
8. identify various technology-related careers, the opportunities in these fields, and their educational requirements.
9. experience the organization and management structure of industry.
10. appreciate the nature of technology and its impact on the individual, society, and the environment.

High School Technology Education Program

The mission of Technology Education at the high school level is to develop technological literacy in each student so that he or she can become an effective and contributing member of society. This is accomplished through instruction and experiences pertaining to technology; its evolution, applications, significance, and career opportunities.

Technology Education's content should focus on the technology systems that are an integral part of our society. These systems include, but are not limited to manufacturing, construction, transportation, communication, and bio-related technologies. Activities will promote problem solving, critical thinking, and the cognitive, psychomotor, and affective development necessary for interaction with modern technology. These laboratory activities will also provide opportunities for the application of science, mathematics, language arts, and social studies knowledge and skills. Students will recognize the multicultural and gender diversity included in the development of technology.

High School Technology Education students will:

1. demonstrate knowledge and skills regarding diverse technology systems, including their functioning and applications.
2. demonstrate knowledge of the nature of technology and the relationships and impacts among technological achievement, the environment, the advancement of science, the individual, and society. The context for this knowledge shall be historical, current, and futuristic.
3. demonstrate the ability to solve problems with technology using a systems approach, higher-order thinking skills, individual and collaborative ingenuity, and a variety of resources including information tools, and materials.
4. make ethical decisions about technology-related issues, including the development and use of technology and technological resources.
5. demonstrate in an experiential setting the safe, effective, and creative use of technological resources — including tools, machines, and materials — in performing technological processes.
6. apply science, mathematics, language arts, social studies, and technological concepts to solve practical problems and extend human capabilities.
7. apply knowledge of and perform tasks representative of technology-based careers, including engineers, technologists, technicians, and craftspersons.
8. recognize the multicultural and gender diversity inherent in the evolution of technology.

Advanced Technology Education

Advanced technology education courses provide opportunities for the in-depth study of technology. The scope of these courses is more narrow than the basic high school course, allowing students to develop more advanced skills and deeper understandings of selected technological systems or processes. The learner outcomes for technology education remain the basis for these courses with one exception. Learner outcome number one states that students will demonstrate knowledge and skills regarding "diverse" technology systems. Advanced technology education students will demonstrate knowledge and skills regarding "selected" technology sytems and processes.

There are a variety of approaches to organizing advanced technology sequences. One is to select a specific human enterprise or institution that utilizes technology such as communications, transportation, manufacturing, commerce, finance, and, then, provide instruction and activities resulting in a significant knowledge and skills base related to the technologies that support the enterprise.

Another approach is to base the advanced technology education course on a technological process such as research and experimentation, technological assessment, or pre-engineering design.

A third method might be to examine the core technologies systems used in all technology systems. The core technologies include mechanical, structural, thermal, electrical, electronic, optical, fluid, bio, and materials technologies. In each approach, students must demonstrate the ability to create technology through the skillful use of tools and equipment and analyze the impact of the technology.

As a continuation of the study of technology, advanced technology education courses will provide opportunities for acquiring deeper understandings of technological concepts and increasingly complex technical skills. The focus of study must be technology — the application of knowledge, tools, and skills to solve practical problems and extend human capabilities. The goal must be the development of technological literacy, which is the ability to interact successfully with technology, to assess the impacts of technology on everyday life and make appropriate decisions, and to apply conceptual knowledge in order to solve problems.

INSTRUCTIONAL UNITS

An instructional unit describes how a topic at a particular grade level is to be taught. It is a guide for teachers to use in working with their students.

An Instructional Unit Consists of Several Important Elements:

- the title or topic to be covered;
- a narrative or outline describing the content to be covered;
- a set of objectives derived from the goals and subgoals defining the scope of the unit or course;
- the activities necessary to reach the objectives;
- a list of resources, equipment, and supplies;
- a description of the evaluation procedures needed to determine whether or not the objectives have been met.

How Are Instructional Units Developed?

The first step in the development process is to examine the existing instructional units. It may be helpful to ask a series of questions about the units:

1. Do the objectives build toward designated goals and subgoals, and do they cover the scope of the topic?
2. Is the content, including skills, adequate enough to cover the topic, and is it current?
3. Are the activities adequate for reaching the objectives, and are they appropriate for the learner?
4. Is the sequence of learning activities within the unit logical?
5. Are the resources listed adequate for the activities?
6. Does the evaluation relate directly to the stated objectives?

After this needs assessment is completed, a series of decisions must be made. First, is it possible simply to revise the existing units? Second, if not, are there available units from an outside source that could be adapted to meet the identified needs? Third, if no such program is available, how can new units be developed locally to improve the curriculum?

Once these questions have been answered, it may be helpful to pilot any resulting curriculum changes. The evaluation of such a pilot can be useful in further refining the new curriculum.

We live in a technological world, rapidly growing more complex and more sophisticated. Each of us needs to know more about technology in order to participate in its development, use and control.

J.R. Johnson
"The Urgent Need for Broad-based Technology Education"

Example of a Local Instruction Unit

DESCRIPTION OF UNIT

As a result of instruction and activities, students will demonstrate knowledge of the impact of technological advancements on the individual, society, and the environment.

1. Objective: Students understand and appreciate the evolutionary nature of technology.
   a. Activities:
      The student:
      — experiences humankind's limited capability by comparing the time requirement to perform a task using a primitive and modern technological device.
      — identifies the resources utilized in the technological device.
      — produces a graphic representation (systems models) to describe the selected technological device.
      — produces graphs that demonstrate that the rate of change in technology is not constant.
      — designs and constructs a display describing the application of the seven technological resources (people, information, tools, energy, capital, time, and materials).
   b. Evaluation:
      Skills, knowledge, and attitudes may be observed through student performance in laboratory work, planning activities, worksheets, and class discussion.
2. Objective: Students examine the relationship between technological achievement and individual lifestyle.
   a. Activities:
      The student:
      — recognizes technology's ability to relieve humans of physically demanding work.
      — identifies innovators and inventors that have been prime movers in the development of technology.
      — researches the invention and produces an oral presentation (including a visual aid, model, or diagram) describing the history, operation, and significance of the topic.
   b. Evaluation:
      Skills, knowledge, and attitudes may be observed through student performance in laboratory work, planning activities, oral presentation, and class discussion.
3. Objective: Students examine the consequences of technological developments on society.
   a. Activities:
      The student:
      — recognizes the potential of technology for positive and negative impacts.
      — identifies positive and negative impacts of selected technology systems.
      — selects and researches the impact of a selected technological advancement on society.
      — designs and produces a visual aid that illustrates the impact of a selected technological advancement on society.
   b. Evaluation:
      Skills, knowledge, and attitudes may be observed through student performance in laboratory work, planning activities, and class discussion.
4. Objective: Students examine the relationship between technological advancement and the quality of the environment.
   a. Activities:
      The student:
      — explores the cause and effect linkages between present day technology and the environment.
      — examines, in a critical way, print and non-print coverage of a technological advancement related to environmental issues.
      — after consideration of scientific information, formulates positions on an environmental issue related to technology.
      — produces graphics representing data that supports the position.
      — uses data to justify a position on an environmental issue related to technology.
   b. Evaluation:
      Skills, knowledge, and attitudes may be observed through student performance in laboratory work, planning activities, oral presentation, and class discussion.

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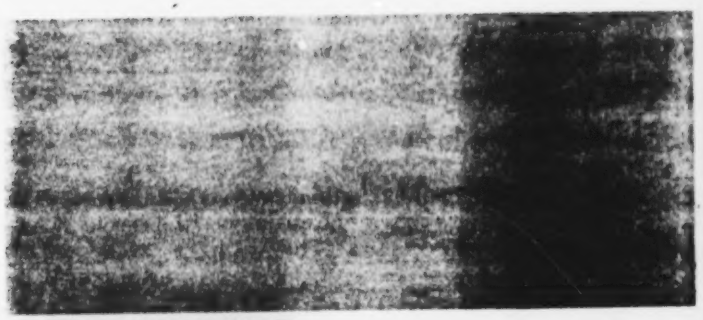

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GLOSSARY

Analyzing Analyzing is the breaking down of a problem into constituent elements or parts for enhanced understanding.

Biotechnology Biotechnology is the application of biological organisms to make and modify products.

Craftsperson A craftsperson is one who performs, with skill and dexterity, tasks which are often repetitive and require manual use of tools or equipment. Many of the skills are learned and perfected through practice and experience.

Engineer An engineer is a person with an engineering degree and/or state license who identifies and solves problems through the production of economically feasible designs.

Information Technology Information technology comprises the processes and techniques of encoding, transmitting, receiving, storing, retrieving, and decoding graphic and electronic messages.

Mock-up A mock-up is a scale model of a finished product, usually made from easily worked materials, to help evaluate the soundness of a design.

Modeling Modeling is the testing of a problem solution or a system without building the solution or system itself. It may use small physical replicas (scale models) or intangible representations of solutions using mathematical techniques or computer programs.

Production Technology Production technology is the processing of resources into goods, standard stocks, and structures.

Prototype A prototype is a model of a final product or structure that is built to help evaluate the soundness of a design and to discover unanticipated problems.

Resources Resources are the things needed to get a job done. In technology systems the resources are: people, information, tools, energy, capital, time, and materials.

Synthesizing Synthesizing is combining elements to produce an enhanced solution to a problem.

System A system is a group of resources (people, information, tools, energy, capital, time, and materials) working together for a purpose.

Systems Approach A systems approach is the use of a formal method (system) to solve technological problems. It includes: defining the problem, setting goals, developing alternative solutions, selecting the best solution, implementing the solution, evaluating the actual results, and making necessary changes.

Systems Model A systems model is a graphic representation of a technology system. It is used to analyze the systems that produce the goods and services needed to solve problems and extend human capabilities.

Technician A technician is a person who performs routine equipment checks and maintenance, carries out plans and designs of engineers, and sets up scientific experiments. A technician has some college or technical school training.

Technological Literacy Technological literacy is the ability to interact successfully with technology, to assess the impacts of technology on everyday life and make appropriate decisions, and to apply conceptual knowledge in order to solve problems.

Technologist A technologist is a person with a college degree who works with engineering design components, applying engineering principles to industrial production, construction, and operation.

Technology Technology is the application of knowledge, tools, and skills to solve practical problems and extend human capabilities.

Technology Education Technology education is an integrated, experience-based instructional program designed to prepare a population that is knowledgeable about technology — its evolution, systems, techniques, utilization, and social and cultural significance.

Technology System A technology system is a combination of materials, devices, structures, information, and energy working together to solve problems and extend human capabilities.

Transportation Technology Transportation technology is processes and techniques used to move people and products.

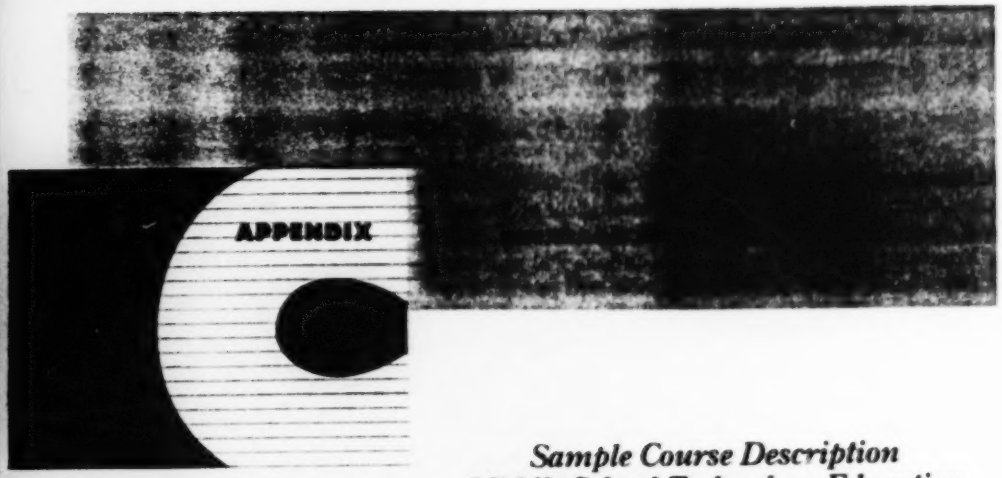
Appendix B — Derivation and Application of Technology Systems

TECHNOLOGY CAREER TEAMS
including:
- Engineers
- Technologists
- Technicians
- Craftspersons

COMBINE THE CORE TECHNOLOGIES
including:
- Mechanical
- Structural
- Fluid
- Electrical
- Electronics
- Optical
- Thermal
- Bio
- Materials

TO PRODUCE TECHNOLOGY SYSTEMS
such as:
- Cars
- Telephone Systems
- Water Filters
- Highways
- Telescopes
- Drill Presses
- Exercise Equipment
- C-D Players
- X-Ray Machines
- Computers
- Microwave Ovens
- Lawnmowers
- Furnaces
- Refrigerators

THAT SUPPORT HUMAN ENTERPRISES & INSTITUTIONS
such as:
- Manufacturing
- Construction
- Transportation
- Communication
- Health & Medicine
- Agriculture
- Energy
- Recreation
- Finance
- Commerce
- Law Enforcement
- Public Safety
- Military
- Education
- Hospitality
- Government
- Personal Services
- Family & Household



Sample Course Description
Middle School Technology Education

Technology Applications 7

Course Description:

Technology Applications 7 is a one-semester course offering an integrated, experience-based instructional program designed to prepare a population that is knowledgeable about technology — its evolution, systems, techniques, utilization, and social and cultural significance. Students will develop problem solving skills through problem solving activities, computer activities, and experimentation. They will become aware of the nature of technology and the impacts of technology through a technology investigation activity that involves research, writing, reporting, and the design and fabrication of a model. Each class session will include an application of math skills to a technology problem. Critical thinking skill development and a review of the technological contributions of men and women of different cultures are also included.

Course Objectives:

The learner will demonstrate knowledge of:

1. the influence of technology on daily living.
2. human purposes for creating and using technology.
3. the positive and negative impacts of technology.
4. the resources used in technology systems.
5. the major technology systems.
6. formal and informal approaches to problem solving.
7. the functioning of technology systems.
8. science concepts applied in modern technology systems.
9. appropriate safety practices for interacting with technology.
10. career opportunities and requirements in engineering and engineering related fields.
11. factors for employability.

APPENDIX C

The learner will demonstrate the ability to:

1. apply a systematic procedure in solving technological problems.
2. use tools and materials in solving technological problems.
3. apply knowledge and ingenuity in solving technological problems.
4. use mathematics to measure, analyze, describe, and predict in solving technological problems.
5. produce technical sketches to plan and communicate solutions to technological problems.
6. design and construct solutions to problems in diverse technology systems.
7. discuss and write about technology systems.
8. read about and discuss technological issues.
9. develop visual aids to represent technology systems, devices, and processes.
10. participate in decision-making regarding the selection and application of technology resources.
11. interact safely with technology systems.
12. cooperate with others.
13. accept and encourage the contributions of others in a team effort.

Units of Instruction:

I. Awareness of Technology
   A. The Significance of Technology
   B. The Evolution of Technology

II. Exploration of Technology Systems
   A. The Systematic Nature of Technology
   B. Major Technology Systems

III. Applications of Technology Systems
   A. Meeting Needs Through Problem Solving
   B. A Systematic Approach to Problem Solving
   C. Problem Solving in Diverse Technology Systems

Sample Course Description
High School Technology Education

Exploring Technology

Course Description:

Exploring Technology is a year long course offered to students in grades nine through twelve that deals with information systems, production systems, transportation systems, and bio-related systems.

The main focus of Exploring Technology is to provide students with a variety of learning experiences that will help them understand, apply, use, and assess technology.

Main themes in the course include the following:

- Defining and describing basic technology systems.
- Examining the history of technology.
- Applying the sytems approach to the study of technology systems.
- Performing processes of diverse systems of technology.
- Understanding the basic concepts of how various technologies work.
- Using tools, machines, and processes safely.
- Assessing technological impacts; including careers, social and environmental impacts, and future developments.
- Solving problems and making decisions related to technology.

Learner Outcomes:

The learner will:

1. define technology and identify the major systems of technology.
2. list major historical developments in the evolution of technology.
3. identify the influences and effects of technology on society, culture, and the environment.
4. identify and describe trends and possible future developments in technology.
5. solve mathematics and measurement problems as they relate to specific technology systems.
6. understand the concept of a systems model and how it applies to systems of technology.
7. demonstrate the ability to solve problems with technology using a systems approach.
8. recognize the multicultural and gender diversity included in past, present, and future uses of technology.
9. develop responsible and safe work attitudes, values, and habits.
10. demonstrate proper use and care of tools and equipment.

Units of Instruction:

1. Introduction to Technology
2. Significance of Technology
3. Systems of Technology
4. History of Technology
5. Invention & Innovation
6. Systems Analysis
7. Problem Solving Methods
8. Lab/Classroom Safety

APPENDIX C

Sample Course Description
High School Technology Education

Exploring Technology Concepts

Course Description:

Exploring Technology Concepts emphasizes the application of knowledge, tools, and skills to solve problems. Students focus on the integration of technology, science principles, and mathematics to be inventive and apply their ingenuity. Students form teams and use the design process of engineering to solve problems. Instruction and problem-solving experiences will center on the use of tools, machines, and materials to design and construct models, devices, and products that creatively solve technological problems. The course is presented as two parts each of one semester duration.

These courses are designed to parallel the ninth grade science courses. Activity areas are divided into four major sections: mechanical systems, natural resources, energy, and innovations in technology.

Course Objectives: Semester A

The learner:

1. identifies and uses the problem solving model in group activities to solve practical problems.
2. recognizes and evaluates the differences between simple and complex machines.
3. combines complex machines with controls to create a working device.
4. creates a system which includes machines, complex machines, controls, and interfaces.
5. demonstrates the safe use of tools, machines, and materials in a laboratory setting.
6. designs models and devices which harness one or more natural elements.
7. demonstrates ways in which the natural elements (earth, fire, air, and water) can be used in technological activities.
8. participates in group problem-solving activities which involve constructing models and devices.
9. Evaluates the effectiveness of the model or device in harnessing the natural elements.

Course Objectives: Semester B

The learner:

1. explores ways in which waves and impulses can be detected, amplified, or transmitted.
2. particpates in group problem-solving activities which use light, sound, and electronics.
3. designs and constructs devices which use waves and impulses.
4. relates interdisciplinary concepts to constructed devices.
5. tests and evaluates wave impulses.
6. incorporates electronic devices into a technology system.
7. brainstorms solutions to technology problems.
8. creates or invents devices or models which effectively solve given problems.
9. constructs devices or models using appropriate materials and safety procedures.
10. evaluates the effectiveness of the model/device in solving given technology problems.

Units of Instruction:

1. Mechanical Systems
2. Natural Resources
3. Energy
4. Innovations in Technology

Sample Course Description
High School Technology Education

Manufacturing Technology

Course Description:

The Manufacturing Systems course provides students with a general introduction to the material processing and management components of a manufacturing activity. The major emphasis will be placed on the production and management processes used to convert resources into manufactured goods and services. Students will become aware of the social and environmental impacts of technology.

Course Objectives:

The learner:

1. demonstrates knowledge of and apply skills related to diverse technology systems.
2. demonstrates knowledge of the impact of technological advancements on the individual, society, and the environment.
3. demonstrates the ability to solve problems with technology using a systems approach, higher order thinking skills, individual and collaborative ingenuity, and a variety of resources including information, tools, and materials.
4. makes informed decisions about technology-related issues.
5. demonstrates in an experiential setting the safe, effective, and creative use of technological resources — including tools, machines, and materials — in performing technological processes.
6. applies science, mathematics, language arts, social studies, and technological concepts to solve practical problems and extend human capabilities.
7. applies knowledge of technology-based careers in terms of: personal interests and abilities; educational opportunities and requirements; career opportunities, trends, and requirements; and other factors for employability and advancement.
8. recognizes the multicultural and gender diversity included in past, present, and future uses of technology.

Units of Instruction:

1. Introduction to Technology Systems
2. Technology and Manufacturing
3. History of Manufacturing
4. Resources for Manufacturing
5. Manufacturing Processes
6. Problem Solving in Manufacturing
7. Manufacturing Impacts

Sample Course Description
Advanced Technology Education

Technology Systems

Course Description:

This year-long course is for students who have an interest in engineering or other high technology careers. It is especially of value to students who are interested in how things work and to those who like to be inventive and apply their ingenuity. Students will use engineering methods and apply tools and materials to solve technological problems. Instruction and problem-solving experiences will deal with mechanical, structural, electrical, electronic, thermal, optical, propulsion, and fluid (hydraulic and pneumatic) systems. Students will also work with robotics and computer control systems.

Course Objectives:

The learner will demonstrate knowledge of:

1. human purposes for creating and using technology.
2. a model for the functioning of technology systems.
3. steps for systematic problem solving.
4. thinking skills applied in engineering problem solving.
5. contributions of women and minorities to engineering and technology.
6. the members of an engineering team and their roles.
7. the function and application of systems.
8. technical sketching concepts.
9. appropriate safety practices for interacting with technology.
10. career opportunities and requirements in engineering and engineering-related fields.
11. factors of employment.

The learner will demonstrate the ability to:

1. apply a systematic procedure in solving technological problems.
2. apply tools and materials in solving technological problems.
3. apply knowledge and ingenuity to technological problems.
4. use mathematics to measure, analyze, describe, and predict in solving technological problems.
5. produce technical sketches to plan and communicate solutions to technological problems.
6. design and construct a solution to problems in each technology system.
7. use tools and equipment to process materials.
8. use tools and equipment to analyze technology systems.
9. discuss and write about technology systems.
10. read about and discuss technological issues.
11. develop visual aids to represent technology systems, devices, and processes.
12. participate in decision-making regarding the selection and application of technology resources.
13. interact safely with technology systems.
14. cooperate with others.
15. accept and encourage the contributions of others in a team effort.

Units of Instruction:

1. Mechanical Systems
2. Structural Systems
3. Thermal Systems
4. Propulsion Systems
5. Electricity
6. Electronics
7. Fluid Systems
8. Optical Systems

Sample Course Description
Advanced Technology Education

Pre-Engineering

Course Description:

Pre-Engineering provides an orientation and exposure to the careers and challenges of engineering. As an experienced-based course, students are actively involved with the practices of various engineering fields, high-technology systems, devices and materials, engineering graphics, and mathematics/science principles through a laboratory-based set of case studies involving problem solving and design experiences.

The major engineering concepts to be included are modeling, systems, optimization, technology-society interaction, design, and ethics. Content is provided in applied engineering graphics, communicating technical information, engineering design principles, material science, research and development processes, manufacturing techniques and systems, and opportunities and challenges of other emerging branches of engineering.

Students manipulate tools, materials, and machines to solve real-world engineering problems using prototypes and models, testing apparatuses, CAD/CAM systems, robotics, computer modeling, and simulations.

Course Objectives: Semester A

The learner will:

1. describe engineering achievements and their impact on society.
2. apply science and mathematics principles and skills to modeling, systems, and organization.
3. analyze the properties of materials to engineer solutions to problems.
4. describe the characteristics and educational requirements of various engineering fields and related careers.
5. communicate technical information.
6. apply the systems approach to problems of engineering and their solution.

Course Objectives: Semester B

The learner will:

1. design, construct, and test physical models to solve real-world problems.
2. apply science and mathematics principles and skills in solving design problems.
3. apply the system of technology assessment to the technology-society interaction.
4. understand the legal and professional ethics of an engineering society.
5. use problem solving techniques to modify an engineered system.
6. work in teams to solve engineering problems.
7. prepare engineering proposals and present a variety of concepts using a variety of media.

Units of Instruction:

1. Modeling
2. Systems
3. Optimization
4. Technology-Society Interaction
5. Design and Ethics
6. Engineering Graphics
7. Communicating Technical Information
8. Engineering Design
9. Materials Science
10. Research and Development Processes
11. Manufacturing Techniques
12. Career Exploration

Maryland State Department of Education

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